Attorney Docket No.: 42P21033

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:

    Yuanhao Sun, et al

Application No.: Not Yet Assigned
    (US National Phase filing of
    PCT/CN2005/000265 under 35 U.S.C. 371)

Filed: Herewith

For: ASYNCHRONOUS NETWORK STACK OPERATION IN AN OPERATING SYSTEM INDEPENDENT ENVIRONMENT

Examiner: Not Yet Assigned

Art Unit: Not Yet Assigned

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Commissioner for Patents
P.O. Box 1450
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Dear Sir:

    Applicants hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or (f), or

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or 365(a) of any PCT international application which designated at least one country other than

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international application having a filing date before that of the application on which priority is

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Prior Foreign Application(s):

Prior Foreign Application Nos.	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Claimed?	Certified Copy Attached?
PCT/CN2005/000265	PCT	03/05/2005	YES	YES

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Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Dated: March 31, 2006

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证　明

CERTIFICATE

IAP20 Rec'd PCT/PTO 9 1 MAR 2006

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申 请 号：　　　　　PCT/CN2005/000265

IONAL APPLICATION NUMBER

请 日：　　　　　05.M AR2005(05.03.2005)

LNAL FILING DATE

名　称 :　　　ASYNCHRONOUS NETWORK STACK OPERATION IN AN

VENTION　　　OPERATING SYSTEM

CERTIFIED COPY OF
PRIORITY DOCUMENT

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二零零五年十二月三十日

DECEMBER 30, 2005

PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

PCT/CN 2005 / 0 0 0 2 6 5
International Application No.

0 5 · MAR 2005 (0 5 · 0 3 · 2 0 0 5)
International Filing Date

RO/CN 中华人民共和国国家知识产权局 PCT International Application
Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference
(if desired) (12 characters maximum) FPEL05150007

Box No. I	TITLE OF INVENTION

ASYNCHRONOUS NETWORK STACK OPERATION IN AN OPERATING SYSTEM INDEPENDENT ENVIRONMENT

Box No. II	APPLICANT	☐ This person is also inventor

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*	Telephone No.
INTEL CORPORATION 2200 Mission College Blvd. Santa Clara, California 95052 United States of America	Facsimile No.
	Teleprinter No.
	Applicant's registration No. with the Office

State *(that is, country)* of nationality: US	State *(that is, country)* of residence: US

This person is applicant for the purposes of:	☐ all designated States	☒ all designated States except the United States of America	☐ the United States of America only	☐ the States indicated in the Supplemental Box

Box No. III	FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

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SUN, Yuanhao N26 Apt 402, Lane 26 Gu Jing Road Shanghai 200336 P. R. of China	☐ applicant only ☒ applicant and inventor ☐ inventor only *(If this check-box is marked, do not fill in below.)*
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State *(that is, country)* of nationality: CN	State *(that is, country)* of residence: CN

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☒ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV	AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	☒ agent	☐ common representative

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	Teleprinter No.
	Agent's registration No. with the Office

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Form PCT/RO/101 (first sheet) (January 2004)   *See Notes to the request form*

Continuation of Box No. III   FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

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This person is:
[ ] applicant only
[X] applicant and inventor
[ ] inventor only *(If this check-box is marked, do not fill in below.)*

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State (that is, country) of nationality: CN
State (that is, country) of residence: CN

This person is applicant for the purposes of:
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[X] the United States of America only
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This person is:
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[X] applicant and inventor
[ ] inventor only *(If this check-box is marked, do not fill in below.)*

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Box No. V	DESIGNATIONS

The filing of this request constitutes under Rule 4.9(a), the designation of all Contracting States bound by the PCT on the international filing date, for the grant of every kind of protection available and, where applicable, for the grant of both regional and national patents.

However,

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☐   KR Republic of Korea **is not designated for any kind of national protection**

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(The check-boxes above may be used to exclude (irrevocably) the designations concerned in order to avoid the ceasing of the effect, under the national law, of an earlier national application from which priority is claimed. See the Notes to Box No. V as to the consequences of such national law provisions in these and certain other States.)

Box No. VI	PRIORITY CLAIM

The priority of the following earlier application(s) is hereby claimed:

Filing date of earlier application *(day/month/year)*	Number of earlier application	Where earlier application is:		
		national application: country or Member of WTO	regional application:* regional Office	international application: receiving Office
item (1)				
item (2)				
item (3)				

☐   Further priority claims are indicated in the Supplemental Box.

The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) *(only if the earlier application was filed with the Office which for the purposes of this international application is the receiving Office)* identified above as:

☐ all items   ☐ item (1)   ☐ item (2)   ☐ item (3)   ☐ other, see Supplemental Box

* *Where the earlier application is an ARIPO application, indicate at least one country party to the Paris Convention for the Protection of Industrial Property or one Member of the World Trade Organization for which that earlier application was filed (Rule 4.10(b)(ii)):* ....
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Choice of International Searching Authority (ISA) *(if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):*

ISA / .CN...

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Date *(day/month/year)*   Number   Country *(or regional Office)*

Box No. VIII	DECLARATIONS

The following declarations are contained in Boxes Nos. VIII (i) to (v) *(mark the applicable check-boxes below and indicate in the right column the number of each type of declaration):*   Number of declarations

☐   Box No. VIII (i)   Declaration as to the identity of the inventor   :

☐   Box No. VIII (ii)   Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent   :

☐   Box No. VIII (iii)   Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application   :

☐   Box No. VIII (iv)   Declaration of inventorship (only for the purposes of the designation of the United States of America)   :

☐   Box No. VIII (v)   Declaration as to non-prejudicial disclosures or exceptions to lack of novelty   :

Box No. IX CHECK LIST; LANGUAGE OF FILING

This international application contains:

(a) in paper form, the following number of sheets:

request (including declaration sheets)	:	4
description (excluding sequence listing and/or tables related thereto)	:	12
claims	:	5
abstract	:	1
drawings	:	5
Sub-total number of sheets	:	27
sequence listing	:	
tables related thereto	:	

(for both, actual number of sheets if filed in paper form, whether or not also filed in computer readable form; see (c) below)

Total number of sheets	:	27

(b) ☐ **only in computer readable form** (Section 801(a)(i))

  (i) ☐ sequence listing

  (ii) ☐ tables related thereto

(c) ☐ **also in computer readable form** (Section 801(a)(ii))

  (i) ☐ sequence listing

  (ii) ☐ tables related thereto

Type and number of carriers (diskette, CD-ROM, CD-R or other) on which are contained the

☐ sequence listing: ....

☐ tables related thereto: ....

(additional copies to be indicated under items 9(ii) and/or 10(ii), in right column)

This international application is accompanied by the following item(s) *(mark the applicable check-boxes below and indicate in right column the number of each item):*

Number of items

1. ☒ fee calculation sheet   : 1

2. ☐ original separate power of attorney :

3. ☐ original general power of attorney :

4. ☐ copy of general power of attorney; reference number, if any: .... :

5. ☐ statement explaining lack of signature :

6. ☐ priority document(s) identified in Box No. VI as item(s): .... :

7. ☐ translation of international application into *(language):* .... :

8. ☐ separate indications concerning deposited microorganism or other biological material :

9. ☐ sequence listing in computer readable form *(indicate type and number of carriers)*

  (i) ☐ copy submitted for the purposes of international search under Rule 13*ter* only (and not as part of the international application) :

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Figure of the drawings which should accompany the abstract:	**Language of filing of the** international application: EN

Box No. X SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

[seal: CHINA PATENT AGENT (HONG KONG) LIMITED 中國專利代理(香港)有限公司 專利申請 專用章]

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1. Date of actual receipt of the purported international application: **0 5 · MAR 2005 (0 5 · 0 3 · 2 0 0 5)**	2. Drawings: ☐ received:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:	
4. Date of timely receipt of the required corrections under PCT Article 11(2):	☐ not received:
5. International Searching Authority (if two or more are competent): ISA /	6. ☐ Transmittal of search copy delayed until search fee is paid

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FEE CALCULATION SHEET
Annex to the Request

PCT/CN 2005 / 0 0 0 2 6 5
International Application No.

0 5 · MAR 2005 (0 5 · 0 3 · 2 0 0 5)
Date stamp of the receiving Office

Applicant's or agent's file reference	FPEL05150007

Applicant
INTEL CORPORATION etc.

CALCULATION OF PRESCRIBED FEES

1. **TRANSMITTAL FEE** . . . . **CNY500** [T]   *CNY 500*

2. **SEARCH FEE** . . . . **CNY1500** [S]   *CNY 1500*
   International search to be carried out by **CN**
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3. **INTERNATIONAL FILING FEE**

   Where items (b) and/or (c) of Box No. IX apply, enter Sub-total number of sheets } 27
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   [i1] first 30 sheets . . . . **CHF1400** [i1]   *CHF 1400*

   [i2] _____ x _____ = _____ [i2]
   number of sheets   fee per sheet
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   [i3] additional component (only if sequence listing and/or tables related thereto are filed in computer readable form under Section 801(a)(i), or both in that form and on paper, under Section 801(a)(ii)):

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4. **FEE FOR PRIORITY DOCUMENT** *(if applicable)* . . . . _____ [P]

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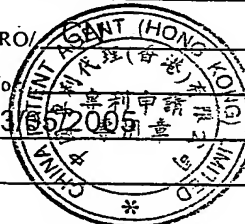
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Form PCT/RO/101 (Annex) (January 2004)   *See Notes to the fee calculation sheet*

ASYNCHRONOUS NETWORK STACK OPERATION IN AN OPERATING SYSTEM INDEPENDENT ENVIRONMENT

TECHNICAL FIELD

[0001]   Embodiments of the invention relate to network stack operation. More particularly, embodiments of the invention relate to uses of an asynchronous network stack that may be used in an operating system independent (e.g., pre-boot) environment.

BACKGROUND

[0002]   The pre-boot environment of an electronic device may be used for remote boot and/or remote installation purposes, which may require the electronic device to download one or more files from a remote server before control of the electronic device is passed to an operating system. In the pre-boot execution environment (PXE), the electronic device may receive one or more files form one or more remote servers. However, as the number of files downloaded increases and/or the functionality of the PXE increases, the current synchronous interface for packet transmission and receipt may become a bottleneck to system performance. Thus, current techniques for uploading and downloading of data in the PXE do not provide optimal performance.

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BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention are illustrated by way of example, and not by way of limitation, in the figures of the accompanying drawings in which like reference numerals refer to similar elements.

Figure 1 is a conceptual block diagram of one embodiment of an asynchronous network stack that operates using a token.

Figure 2 is a block diagram of one embodiment of an embedded firmware agent.

Figure 3 is a conceptual flow diagram of one embodiment of a token passing sequence between layers in an asynchronous network stack.

Figure 4 is a conceptual flow diagram of one embodiment of a sequence between layers in an asynchronous network stack to cancel a previously requested/scheduled operation using a token.

Figure 5 is a block diagram of one embodiment of an electronic system.

DETAILED DESCRIPTION

[0003]   In the following description, numerous specific details are set forth. However, embodiments of the invention may be practiced without these specific details. In other instances, well-known circuits, structures and techniques have not been shown in detail in order not to obscure the understanding of this description.

[0004]   Described herein are techniques for asynchronous network stack operation in an operating system independent environment. In one embodiment, the asynchronous operation may be supported by a token-based stack design that may be used for network communications in the pre-boot environment, or any operating system independent environment. The techniques provide an asynchronous calling framework for network stack drivers that represent various operational layers. In one embodiment, the driver actions (e.g., transmit, receive) are schedulable.

[0005]   Described herein are techniques for use of a token to support operation of the asynchronous network stack. In one embodiment, the token may have the following four characteristics: 1) the token may identify a requested action (e.g., to transmit a data packet, to receive a data packet), 2) a status indicator to indicate the current phase of the token or the result of the request, 3) an event to provide notification of a status change, and 4) a context. In alternate embodiments, additional and/or different token characteristics may be supported.

[0006]   **Figure 1** is a conceptual block diagram of one embodiment of an asynchronous network stack that operates using a token. The conceptual block diagram of Figure 1 includes specific network layers and protocols; however, in alternate embodiments different protocols and/or layers may be supported.

[0007]   In one embodiment, the physical implementation of each network layer may be configured to communicate with embedded firmware agent 190. In alternate embodiments, one or more of the layers may not be configured to communicate with embedded firmware agent 190. Application 100 may represent any type of application, whether under operating system control or not, that includes functionality to communicate over a network external to the host device. Application 190 may be any type of application known in the art.

[0008]   In one embodiment, Application 190 may request services, for example, transmission of a network packet, by passing a token to Multicast Trivial File Transfer Protocol layer 110. In general, TFTP is a transfer protocol that is simpler to use than the File Transfer Protocol (FTP), but provides less functionality. For example, TFTP does not support user authentication or directory visibility. TFTP uses the User Datagram Protocol (UDP) rather than the Transmission Control Protocol (TCP). One embodiment of TFTP is described formally in Request for Comments (RFC) 1350, Rev. 2, published July 1992.

[0009]   TFTP has been expanded to include a multicast option as described in RFC 2090, published February 1997. Multicast TFTP classifies client devices as active clients or passive clients. There is only one active client at a time. The

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active client communicates with a server to download data using a stop-and-wait
ARQ flow and error control technique to a negotiated group address. When the
requested activity has been accomplished, MTFTP layer 110 returns an event
notification with the token requesting the activity. Use of the token and the event
notification may allow application 190 to continue operation and engage in other
tasks during the time required to accomplish the requested activity.

[0010]   In one embodiment, the token passing technique may be employed
between each network stack layer. That is, between MTFTP layer 110 and UDP
layer 120, between UDP layer 120 and IP layer 130, between IP layer 130 and
Managed Network Protocol (MNP) layer 140, and between MNP layer 140 and
NIC driver 150.

[0011]   In one embodiment, MTFTP layer 110, UDP layer 120, IP layer 130
and MNP layer 140 may represent layered network drivers. In a synchronous
network stack, the calling layer will halt operation while the called layer performs
the requested operation. In contrast, using the asynchronous network stack
techniques described herein, a layer may request an operation from a lower layer
using a token and perform operations not dependent upon the requested operation
while the operation is being performed by the lower layer.

[0012]   For example, IP layer 130 may request a received IP packet and may
prepare a receive token and an associated notify event. After passing the receive
token to MNP layer 140, IP layer 130 may engage in other operations, for
example, preparation of a packet for transmission. When a packet is received

from the network and processed by MNP layer 240, the received packet may be
stored and MNP layer 240 may notify IP layer 140 of the received packet via an
event with token received from IP layer 140. In response to the event, IP layer
140 may process the received packet.

[0013]   In one embodiment, embedded firmware agent 190 may allow the
asynchronous network stack to operate in an operating system independent
environment. **Figure 2** is a block diagram of one embodiment of an embedded
firmware agent. In the example of Figure 2 the embedded firmware agent may
have an interface compliant with an Extensible Firmware Interface (EFI) as
defined by the EFI Specifications, version 1.10, published November 26, 2003,
available from Intel Corporation of Santa Clara, California. In alternate
embodiments, other firmware components can also be used. .

[0014]   In one embodiment, the embedded firmware agent may include agent
bus 200 coupled with system interface 205. System interface 205 may provide an
interface through which the embedded firmware agent communicates with the
host system. The embedded firmware agent may further include agent network
interface 250 that may be coupled with an external network (not shown in Figure
2) to allow the embedded firmware agent to communicate with a remote
electronic device. Agent network interface 250 may support wired and/or
wireless network communications.

[0015]   In one embodiment, the embedded firmware agent further includes
dynamic memory 210 that may be coupled with agent bus 200. Dynamic

memory 210 may provide storage for instructions and/or data to be used during operation. The embedded firmware agent may further include non-volatile storage 220 that may be coupled with agent bus 200 to store static data and/or instructions. In one embodiment, the embedded firmware agent may include control circuitry 230 coupled with agent bus 200 that may perform control operations and/or execute instructions provided by dynamic memory 210 and/or non-volatile storage 220.

[0016]   In one embodiment, the embedded firmware agent may support operations that are independent of the host operating system. These operations may be, for example, pre-boot operations that are performed prior to the operating system being loaded, or while the operating system is being loaded, but prior to transfer of control to the operating system. These operations may also be independent of the host operating system when the host operating system has control of the host electronic device. For example, in one embodiment, the embedded firmware agent may be coupled with a host processor via an interrupt interface with, for example, the SMI pin of a Pentium® processor or with the PMI pin of an Itanium® processor (generically, xMI line). Other system interrupt signals may be used for other processors.

[0017]   Because use of tokens as described herein may allow layer operations to be schedulable, parallel technology including, for example, hyperthreading, multi-processor systems and multi-threading may be incorporated into the firmware level design and allow stack drivers to perform parallel operations.

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With use of, for example, an interrupt or a timer, an embedded firmware agent may interact with the asynchronous network stack to enable network operations including, for example, a background web server or a background telnet server, to be supported in a pre-boot or operating system independent environment. Use of status and/or context that may be supported by the token may allow network stack layers to communicate status without use of other channels as may be required by synchronous stack configurations.

[0018]   **Figure 3** is a conceptual flow diagram of one embodiment of a token passing sequence between layers in an asynchronous network stack. In one embodiment, the upper network stack may generate or prepare a token to request a specific operation (e.g., transmission or receipt of a packet). In one embodiment, the token may include a notify event and/or contextual information that may be used to communicate status or context of the requested operation. In one embodiment, the upper stack layer may call a method or function of the lower stack layer to pass the token to the lower stack layer.

[0019]   In response to receiving the token, the lower stack layer may perform and/or schedule the operation requested (e.g., transmit, receive) with the token. Upon completion of the requested operation, the lower stack layer may generate or prepare a signal event that communicates the completion of the requested operation to the embedded firmware agent. In one embodiment, the embedded firmware agent may notify the upper stack layer of completion of the requested operation with an event notification. In response to receiving the event

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notification, the upper stack layer may perform any operation completion handling and delete the token.

[0020]   **Figure 4** is a conceptual flow diagram of one embodiment of a sequence between layers in an asynchronous network stack to cancel a previously requested/scheduled operation using a token. In one embodiment, the upper network stack may generate or prepare a cancel request to cancel a previously generated token. In one embodiment, the cancel request may include the token and/or contextual information that may be used to communicate status or context of the token.

[0021]   In one embodiment, the upper stack layer may call a method or function of the lower stack layer to pass the cancel request to the lower stack layer. In response to receiving the cancel request, the lower stack layer may abort the previous operation identified by the token and then generate or prepare a signal event to embedded firmware agent. In one embodiment, the embedded firmware agent may transmit a dispatch event signal to the upper stack layer, which may cause the upper stack layer to perform any error handling and delete the token.

[0022]   In one embodiment, the techniques of Figures 3 and 4 can be implemented as instructions executed by an electronic system. The instructions may be stored by the electronic device or the instructions can be received by the electronic device (e.g., via a network connection). **Figure 5** is a block diagram of one embodiment of an electronic system. The electronic system illustrated in

Figure 5 is intended to represent a range of electronic systems, for example, computer systems, network access devices, etc. Alternative systems, whether electronic or non-electronic, can include more, fewer and/or different components. The electronic system of Figure 5 may represent a server device as well as the one or more client devices.

[0023]   Electronic system 500 includes bus 505 or other communication device to communicate information, and processor 510 coupled to bus 505 to process information. While electronic system 500 is illustrated with a single processor, electronic system 500 can include multiple processors and/or co-processors. Electronic system 500 further includes random access memory (RAM) or other dynamic storage device 520 (referred to as memory), coupled to bus 505 to store information and instructions to be executed by processor 510. Memory 520 also can be used to store temporary variables or other intermediate information during execution of instructions by processor 510.

[0024]   Electronic system 500 also includes read only memory (ROM) and/or other static storage device 530 coupled to bus 505 to store static information and instructions for processor 510. In one embodiment, static storage device 530 may include an embedded firmware agent. In alternate embodiments, other firmware components can also be used.

[0025]   Data storage device 540 is coupled to bus 505 to store information and instructions. Data storage device 540 such as a magnetic disk or optical disc and corresponding drive can be coupled to electronic system 500.

[0026]   Electronic system 500 can also be coupled via bus 505 to display

device 550, such as a cathode ray tube (CRT) or liquid crystal display (LCD), to

display information to a user. Alphanumeric input device 560, including

alphanumeric and other keys, is typically coupled to bus 505 to communicate

information and command selections to processor 510. Another type of user

input device is cursor control 570, such as a mouse, a trackball, or cursor

direction keys to communicate direction information and command selections to

processor 510 and to control cursor movement on display 550. Electronic system

500 further includes network interface 580 to provide access to a network, such

as a local area network. Network interface 580 may further include one or more

antennae 585 to provide a wireless network interface according to any protocol

known in the art.

[0027]   Instructions are provided to memory from a storage device, such as

magnetic disk, a read-only memory (ROM) integrated circuit, CD-ROM, DVD,

via a remote connection (e.g., over a network via network interface 580) that is

either wired or wireless providing access to one or more electronically-accessible

media, etc. In alternative embodiments, hard-wired circuitry can be used in place

of or in combination with software instructions. Thus, execution of sequences of

instructions is not limited to any specific combination of hardware circuitry and

software instructions.

[0028]   An electronically-accessible medium includes any mechanism that

provides (i.e., stores and/or transmits) content (e.g., computer executable

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instructions) in a form readable by an electronic device (e.g., a computer, a personal digital assistant, a cellular telephone). For example, a machine-accessible medium includes read only memory (ROM); random access memory (RAM); magnetic disk storage media; optical storage media; flash memory devices; electrical, optical, acoustical or other form of propagated signals (e.g., carrier waves, infrared signals, digital signals); etc.

[0029] Reference in the specification to "one embodiment" or "an embodiment" means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the invention. The appearances of the phrase "in one embodiment" in various places in the specification are not necessarily all referring to the same embodiment.

[0030] While the invention has been described in terms of several embodiments, those skilled in the art will recognize that the invention is not limited to the embodiments described, but can be practiced with modification and alteration within the spirit and scope of the appended claims. The description is thus to be regarded as illustrative instead of limiting.

CLAIMS

What is claimed is:

1.   A method comprising:

sending a request for a first network operation from a first network stack layer to a second network stack layer using a token-based asynchronous inter-layer communication protocol in an operating system independent environment;

performing, with the first network stack layer, a second network operation prior receiving an indication of completion of the first network operation; and

sending the indication of completion of the first network operation from the second network stack layer to the first network stack layer via an embedded firmware agent in response to completion of the first network operation.

2.   The method of claim 1 wherein the first network stack operation comprises a data transmission operation.

3.   The method of claim 1 wherein the first network stack operation comprises receipt of data via a network connection.

4.   The method of claim 1 wherein the operating system independent environment comprises a pre-boot execution environment.

5.   The method of claim 1 wherein the first network stack layer and the second network stack layer are both communicatively coupled with an embedded firmware agent in a host system that supports the asynchronous token-based network stack.

6.   The method of claim 1 wherein the indication of completion includes at least the token.

7.   An apparatus comprising:

an embedded firmware agent capable of functioning in an operating system independent manner;

control circuitry to support a token-based asynchronous inter-layer communication protocol communicatively coupled with the embedded firmware agent to send a request for a first network operation from an upper network stack layer to a lower network stack layer using a request including a token, performing, with the upper network stack layer, a second network operation prior receiving an indication of completion of the first network operation, and send the indication of completion of the first network operation from the second network stack layer to the first network stack layer via an embedded firmware agent in response to completion of the first network operation.

8.   The apparatus of claim 7 wherein the first network stack operation comprises a data transmission operation.

9.   The apparatus of claim 7 wherein the first network stack operation comprises receipt of data via a network connection.

10.   The apparatus of claim 7 wherein the operating system independent environment comprises a pre-boot execution environment.

11.   The apparatus of claim 7 wherein the indication of completion includes at least the token.

12.   An article comprising a computer-readable medium having stored thereon instructions that, when executed, cause one or more processing components to:

send a request for a first network operation from a first network stack layer to a second network stack layer using a token-based asynchronous inter-layer communication protocol in an operating system independent environment;

perform, with the first network stack layer, a second network operation prior receiving an indication of completion of the first network operation; and

send the indication of completion of the first network operation from the second network stack layer to the first network stack layer via an embedded firmware agent in response to completion of the first network operation.
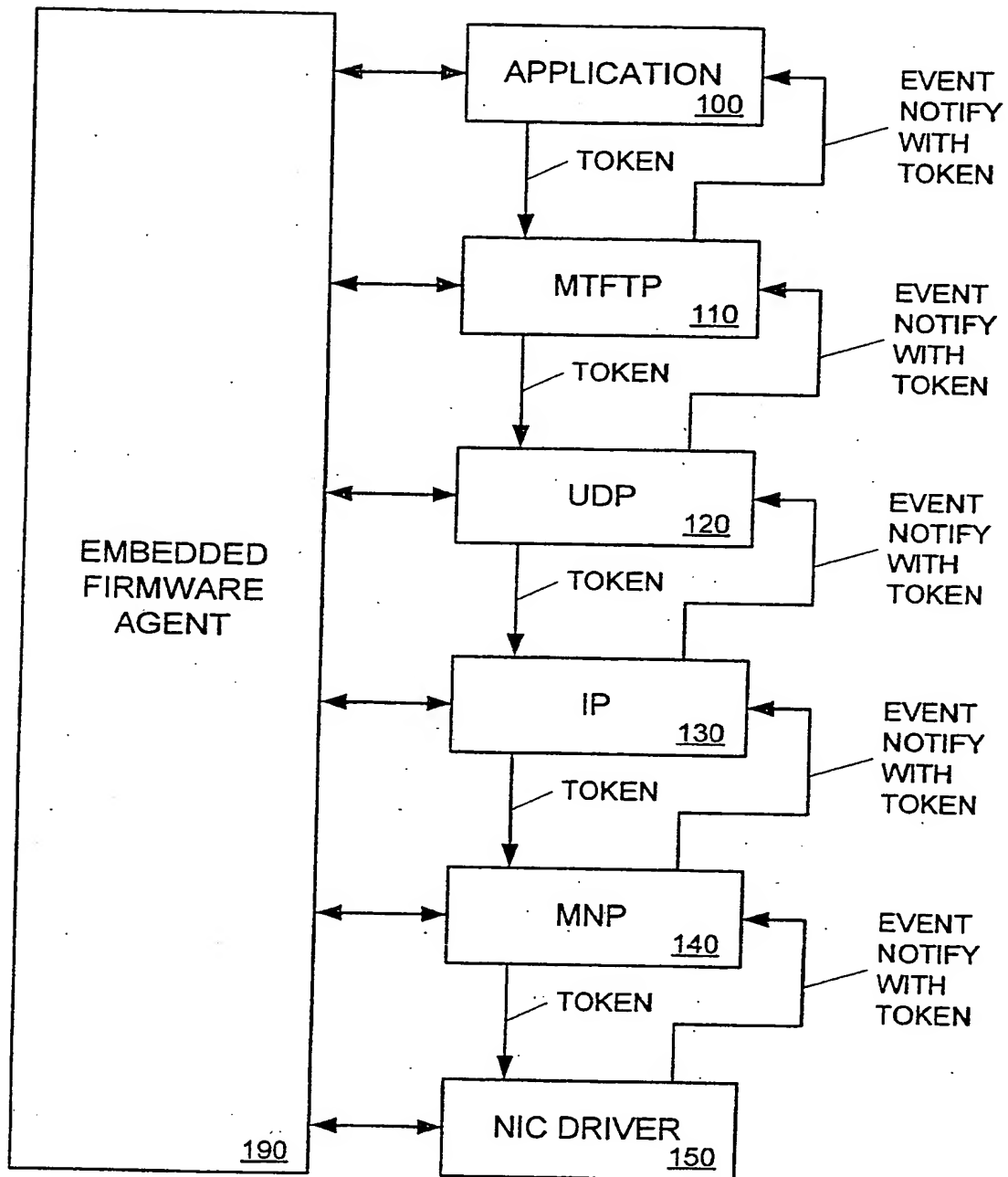
13. The article of claim 12 wherein the first network stack operation comprises a data transmission operation.

14. The article of claim 12 wherein the first network stack operation comprises receipt of data via a network connection.

15. The article of claim 12 wherein the operating system independent environment comprises a pre-boot execution environment.

16. The article of claim 12 wherein the indication of completion includes at least the token.

17. A system comprising:
one or more processing components;
a network interface coupled with the one or more processing components; and
a computer-readable medium coupled with the one or more processing components having stored thereon instructions that, when executed, cause the one

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or more processing components to send a request for a first network operation from a first network stack layer to a second network stack layer using a token-based asynchronous inter-layer communication protocol in an operating system independent environment, perform, with the first network stack layer, a second network operation prior receiving an indication of completion of the first network operation, and send the indication of completion of the first network operation from the second network stack layer to the first network stack layer via an embedded firmware agent in response to completion of the first network operation.

18. The system of claim 17 wherein the first network stack operation comprises a data transmission operation.

19. The system of claim 17 wherein the first network stack operation comprises receipt of data via a network connection.

20. The system of claim 17 wherein the operating system independent environment comprises a pre-boot execution environment.

ABSTRACT

Techniques for operation of an asynchronous stack in a pre-boot environment. A token-based stack design may be used to support communications between network stack layers.
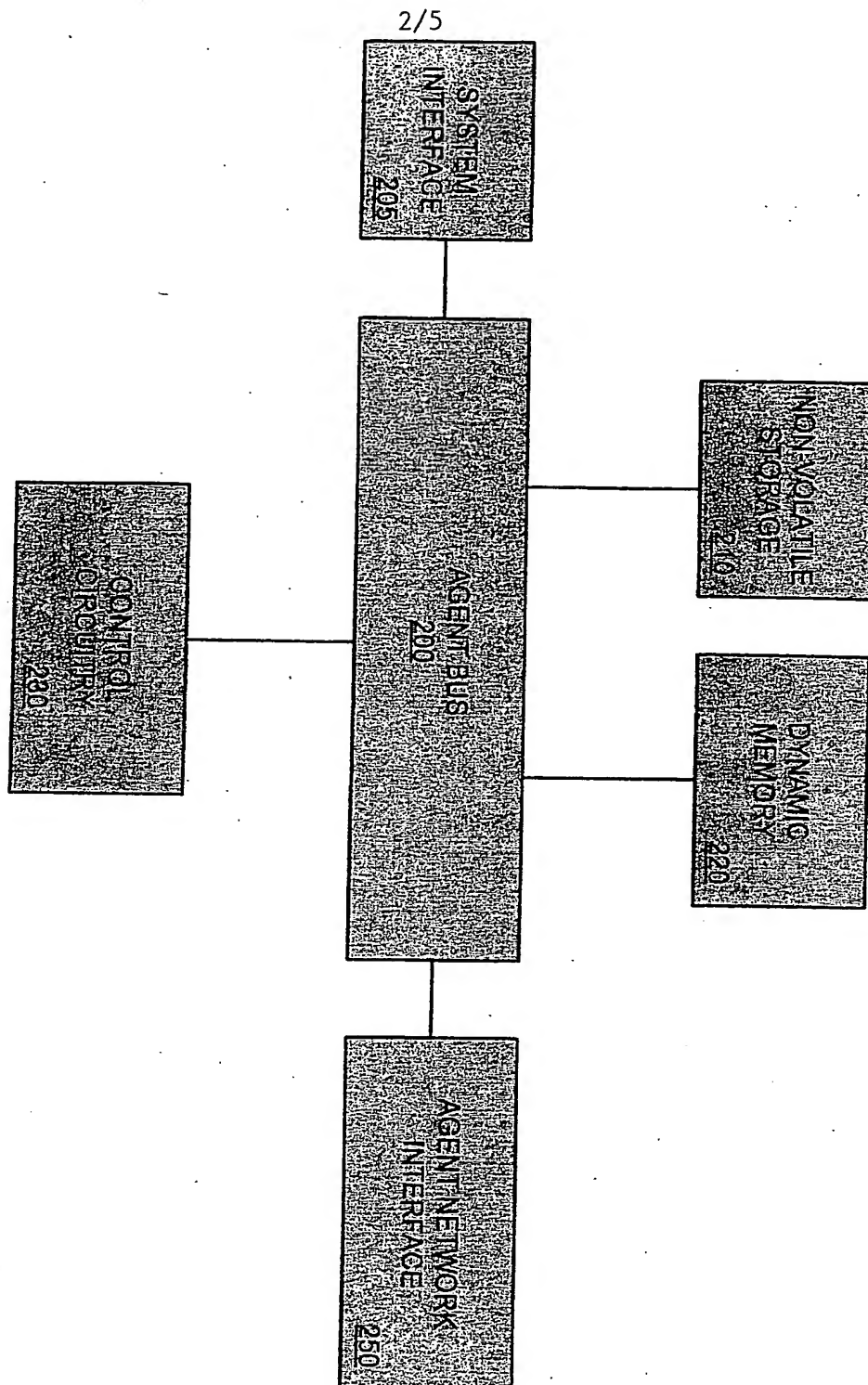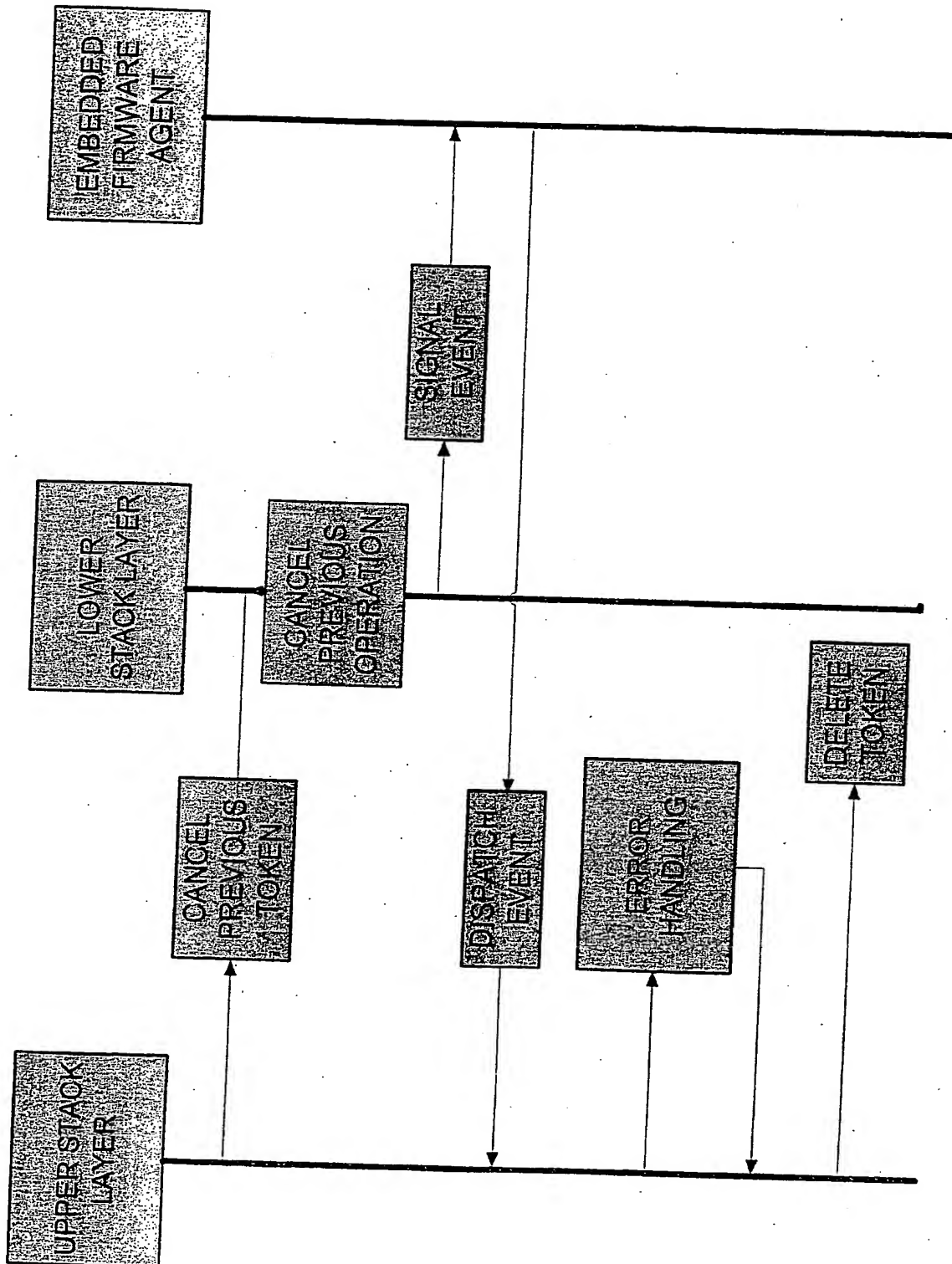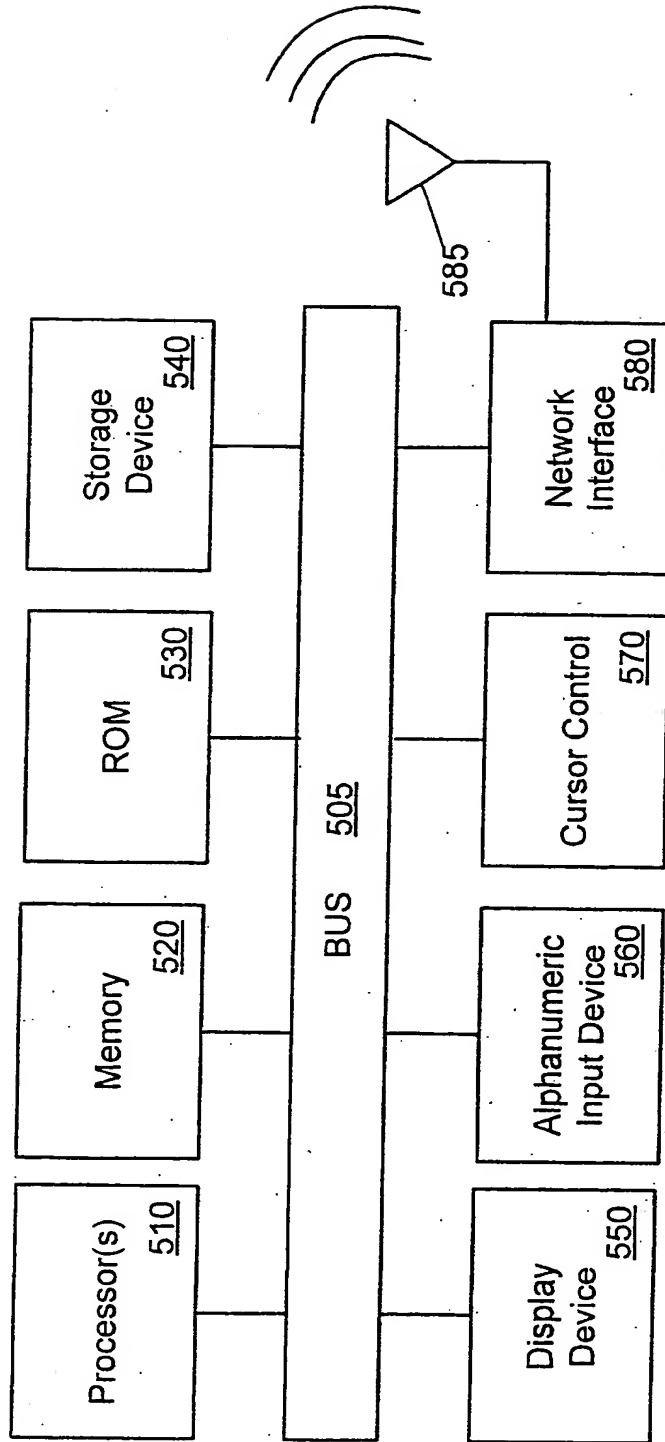
Fig. 1

FIG. 2

FIG. 3

FIG. 4

500

Processor(s) 510	Memory 520	ROM 530	Storage Device 540

BUS 505

585

Display Device 550	Alphanumeric Input Device 560	Cursor Control 570	Network Interface 580

Fig. 5